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DATE: April 12, 2017

TO: Mark Sprenger, EPA/ERT Work Assignment Manager

FROM: Christopher Gussman, SERAS Task Leader

THROUGH: Kevin Taylor, SERAS Program Manager

SUBJECT: **Technical Memorandum: Field and Laboratory Investigation R9 Cove Irrigation Crops Study, Cove, Arizona Work Assignment No. SERAS-297**

BACKGROUND

The R9 Cove Irrigation Crops Study (Site) is located in the northeast section of Arizona (Az) on Navajo Land in Cove, Az. The Site consists of the Cove Wash watershed, which includes 50 of the 70 abandoned uranium mines within the Lukachukai Mountains. The Cove Wash watershed is located within the Navajo Nation and extends from the highest elevations in the Lukachukai Mountains and downstream to Cove, Arizona. The watershed contains approximately 52 miles of tributaries and is defined by the U.S. Geological Survey (USGS) as Hydrologic Unit Code 14801050903. Annual precipitation averages 12 to 16-inches annually throughout the watershed. The Cove Wash watershed is not a known drinking water source, but may have been historically used by residents before municipal drinking water was provided approximately 20 years ago. However, there is a possibility that some residents may use or could potentially use surface water and groundwater wells for drinking water. Additionally, the Cove Wash watershed is used extensively to provide drinking water for grazing livestock and for crop irrigation.

Uranium (U) outcrops were discovered within the Cove Wash watershed in the late 1940s. U and vanadium (V) ore shipments from the watershed began in 1950. The mine sites were situated along the mesas throughout and upstream of the watershed. Uranium and vanadium mining ceased sometime in the 1960s and the mine sites were abandoned. The Navajo Nation reclaimed this area in the 1990s, but mine waste remains present throughout the watershed.

Scientific, Engineering, Response, and Analytical Services (SERAS) personnel were tasked with evaluating Contaminants of Potential Concern (COPCs) in and around the Cove Wash (Figure 1). Cove Wash runs from the mesas and through an area inhabited by several farms and residences. This area of interest is downstream of a major dam ("Diversion Dam 1") in areas that are farmed or show evidence of having been historically farmed. The field investigation explored the area of interest focusing on irrigation features and active and historical farms and properties. Several dams, canals and irrigation ponds exist throughout the region. A “Revised Sampling and Analysis Plan-Cove Wash Watershed Assessment Site (Navajo Nation, Cove Chapter, Apache County, Arizona)” dated March 2016 by Weston Solutions was supplied by the EPA/ERT WAM along with maps of known irrigation storage ponds and farm fields in this area as a starting reference The storage ponds generally consist of an earthen berm to contain water with a flood gate on the lower end which supplies water to a cultivated field. These ponds may be fed by runoff or through manmade canals connecting with Cove Wash.

Soil, water and plants were analyzed for a suite of metals including aluminum (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), boron (Bo), cadmium (Cd), calcium (Ca), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), magnesium (Mg), molybdenum (Mo), nickel (Ni), potassium (K), selenium (Se), silver (Ag), sodium (Na), strontium (Sr), thallium (Tl), thorium (Th), U, V and zinc (Zn). A limited number of samples were also submitted for Radium 226 (Ra-226) and Radium 228 (Ra-228) analyses. Based on screening level exceedances in historic studies, As, Ba, Pb, Mo, Ra, Se, Th and U have been identified as COPCs at this site. All of these COPCs are evaluated in the focused risk assessment included. The objective of the study is to determine whether active and historic irrigation systems (irrigation canals, storage ponds and gates) and farm fields within the Cove Chapter are impacted by COPCs from the abandoned uranium mines in the watershed and whether there may be associated risk to wildlife receptors exposed to surface water, soil, sediment, or by ingesting vegetation grown in sampled areas.

ACTIVITIES

EPA, ERT, and SERAS personnel, assisted by a group of college environmental science student interns from Dine College (Tsaile, Arizona), examined and sampled the area of interest in late June of 2016. Daily activities were recorded in a field logbook. A copy of water quality measurements collected in the field is included in Appendix A. At the time of sampling very little flowing or standing water existed in Cove Wash nor the associated holding ponds. Sampling focused on all of the known holding ponds of the area and some of the associated fields as well as areas along Cove Wash and its associated irrigation system. Cove Wash itself was walked within the area of interest to visually determine the location of canals and dams. Goals of this effort and analytical details are outlined in the June 2016, QUALITY ASSURANCE PROJECT PLAN/ R9 Cove Irrigation Crops Study/ Cove, Arizona. EPA, ERT, SERAS, and associated interns were provided space in the library of the Cove Chapter House as a base station. Two way radio communication was set up to allow communication among the various field parties.

Canals, Ponds, and Water Features

There is concern that contaminants from the mines or mining activities can potentially be carried by water down Cove Wash and end up in irrigation systems or farm fields. Standing water in irrigation storage ponds may also potentially be consumed by livestock. During the field investigation an effort was made to better understand the current and historic irrigation systems associated with Cove Wash. Key features along Cove Wash were noted and recorded, obvious irrigation canals were mapped, and the perimeters of the storage ponds were walked and recorded. An unknown bridge and dump area were also noted and recorded in the field.

Although there was clear evidence that water often flows swiftly and deeply within the Cove Wash, very little water was present at the time of the field investigation. Most of the bottom of the Cove Wash and associated systems were dry. The canals, storage ponds, and other water features may be observed in Figure 2. The main dam, “Diversion Dam 1”, is a large permanent cement structure located upstream of most dwellings and farms in the area of interest but downstream of the mesas and mines. Flow of water through Cove Wash occurs in a generally north direction. Approximately 5,000 feet downstream of Diversion Dam 1 is another permanent cement Dam (“Diversion Dam 2”). Stones, sediment, and associated debris from the wash reach the top of the backside of this dam. Diversion Dams 3 and 4 are historical but still identifiable only from the presence of some stones and logs. These further downstream dams were much smaller structures made with stone and wood and were currently identified from some partial remnants remaining in Cove Wash. A few unknown landmark features were discovered in the field and recorded. These included a dump area, a small bridge, and an additional storage pond. Soil from the latter was labeled the “asbestos pond” as it collected from this unused storage pond that was partially excavated for the disposal of asbestos debris.

The perimeters of the storage ponds are outlined in Figure 2 and represent all known storage ponds in this area. Most of these ponds are associated with active or former farm fields, and nearly all the ponds exist on land with associated dwellings. The storage ponds were easily identified and the associated earthen berms readily identified in the landscape. Many or most of these storage ponds still had an outlet on their lower end, consisting of a pipe and a wooden gate cover on a wooden tower with a platform on top. The gate is opened with a crank on top of the platform to allow water to gravity flow into the fields on the other side of the berm. Most of these outlet structures were weathered and in poor condition. Many of these ponds had not been used for several decades and sage and other scrub and sometimes small trees had begun to fill in the bottom of many of the ponds. A few of the ponds were in current or recent use and the bottom was grass or earth, often with a cracked surface soil showing recent saturation. One of the ponds still contained shallow water at the time of sampling and was currently in use, the associated field containing the remnants of a crop planted the previous year. A second pond also had some minimal water at the time of sampling and an associated crop along with some fruit trees. A long, complex, and well maintained irrigation canal exists to feed these active storage ponds. The origin of this canal occurs at Diversion Dam 1. Most of the storage ponds no longer had active canals feeding them although it is likely some of these may have had irrigation canals historically. Some of the storage ponds are located at the bottom of hills and situated to receive surface water directly from precipitation runoff. Navajo residents indicated that several decades ago, when the farms were more active, the area of interest generally received much more precipitation than in recent years. One resident shared memories of swimming in his storage pond during his youth at times when it filled with water.

Field Sampling of Soil, Water, and Plants

In an effort to determine distribution of contaminants related to the mining activities and evaluate potential risk of contaminants, SERAS personnel sampled soil, water and plants (crops), where present, within the area of interest. Soil samples were collected judgmentally from the irrigation canals, bottoms of the storage ponds, and in cultivated or historically cultivated fields. Water and plant samples were very limited during the field investigation as standing water and crop plants were only found in a couple of locations. Sampling locations were biased and selected by EPA, ERT, and SERAS personnel in the field in an effort to collect a representative range of potential representative contaminants. An attempt was made to find one or more highly contaminated soil(s) from the mesas near the former mines as a worst case soil. However, field screening did not locate any appropriate highly contaminated soil. A single bulk soil sample was provided by another EPA contractor from one of the mines (mesa 1, mine 13). A background control soil sample was collected north and outside the area impacted by Cove Wash. In addition, a sample was collected from a dry storage pond west of and not associated with Cove Wash which may also represent a background control sample. The rest of the soil samples were collected from farms, ponds, and canals throughout the area of interest. Figure 3 shows the locations sampled, associated samples, and other noted points of interest during the field investigation.

To assist in selecting sampling locations and for health and safety concerns, surface soils were screened in the field for radioactivity with a Ludlum Model 19 Micro R Meter. This quick screening in the field helped select areas to collect soil samples. The field readings in Microrems per hour (uR/hr) were recorded at each soil sampling location. The lowest readings, representing normal background for the area, appeared to be about 11-14 uR/hr. Results of the field radiation measurements may be viewed on Figure 4.

Water samples were limited at the time of fieldwork. Water was collected from two of the irrigation ponds although the water was very shallow at the time of sampling. Extremely shallow muddy water collected from one of the ponds had completely evaporated two days later. A third surface water sample was collected just upstream of Diversion Dam 1. A small thunderstorm occurred further up the mesa during the afternoon one day, and a small stream of fresh surface water reached the vicinity of Diversion Dam 1 the following morning and was sampled at that time.

It was planned to collect plants, particularly crop plants, from the area of interest. The local people traditionally grew corn, wheat, oats, squash, pumpkins, and other crops. Very few farms are actually in production at this time. Lack of active farming appeared to be a combination of factors including fear of soil contaminants, persistent drought, and general aging of much of the population. Wheat was collected from one active (along with collocated soil) and alfalfa from another. In addition, a sample of Pinyon nuts collected from up on the mesas near the mines were kindly provided by one resident as a third plant sample. Collocated soil samples were collected with the wheat and alfalfa plant samples.

All soil, water, and plant samples were analyzed for the metals of interest. A few additional samples were also sent for analyses of R-226 and R-228. U-238 has a half-life of 4.5 billion years and eventually decays to the stable lead 206. Some of the elements have very short half-lives, such as Bisumuth 214 which has a half-life of 20 minutes. There is no need to analyze the soil for these shorter lived elements. Distribution of some of the more stable elements, like total U, Th, and Pb will help determine distribution of the mining waste. Uranium concentrations should provide a key to the distribution of mine related soil contamination.

Laboratory Study

Twelve larger, bulk samples (5-gallon buckets) of soil were collected for laboratory studies in Edison, NJ. These composite samples represent a range of contaminants and soil types in this area. Ten of the samples were collected from farm fields and storage ponds. LabS11 was a control soil collected one property that was not irrigated and furthest from the mine source, and LabS12 represented a “worst case” soil collected from the vicinity of the mines. Figure 5 shows where the soils were collected for the laboratory study.

After homogenization of each bucket of soil, and upon initiation of the study, one representative composite sample was collected from each location for detailed agronomic analyses (Appendix B). The remainder of each treatment batch was divided into three replicate portions (A through C). An initial soil aliquot was removed from each of the three portions for total metals analyses (Appendix C). Each of the three replicate portions was divided into two separate pots for growing two different crops. Seed was obtained from the Sustainable Seed Company (Chico, California). Since the SERAS Scientist was not able to locate sufficient quantity or type of appropriate local seed during fieldwork, seed of nonhybrid, regionally adapted cultivars that could potentially be purchased regionally and grown in the study area were substituted. Wheat (*Triticum aestivum*), cultivar ‘Sonora’ was selected to be grown for 28-days per crop in each pot. ‘Lisbon’ onion was to be grown for the same length of time but the period of growth was extended an additional month due to slower growth of the onion plants. Each replicate 6-inch pot contained 1.5 kg of the desired soil mixture and was replicated three times per sample location. Twenty-five (25) seeds of wheat or approximately 40 onion seeds were planted in each pot and grown in the ERT/SERAS Plant Growth Room for the duration of the study. The plants were grown under fluorescent lights and a 16-hour photoperiod. Three replicate pots were also set up using a commercial potting mixture as a positive growth control. The wheat germinated and grew well, based on overall appearance and comparison to plants grown in potting soil, for the duration of the study in all of the soils. After 28 days the above ground plant material was harvested, oven dried, weighed, finely chopped and delivered to the selected laboratory to be analyzed for metals of interest.

The soil in each pot was homogenized and aliquots were collected for both Bioaccessability Testing by Ohio State University (OSU) and for an agronomic analyses by the Rutgers University Soil Testing Laboratory (New Brunswick, NJ). Bioaccessibility Testing consisting of a calcium chloride neutral salt extraction was performed by the laboratory of Dr. Nick Basta (Ohio State University) focusing on As, Ba, Mo, Se and U. Results of the agronomic analyses may be found in Appendix B and the salt extraction found in Appendix D.

RESULTS AND OBSERVATIONS

Soils

Sufficient soil for samples was easily collected throughout the area of interest due to there being minimal rocks, vegetation or other debris. The area soil was generally fine and relatively free of gravel and organic debris. Even those farm fields which had not been plowed for many years still had minimal vegetation and were easily sampled. Some of the abandoned storage ponds did have vegetation growing in them although many of the ponds contained depressional areas where water pooled after storm events preventing vegetation reestablishment. These particular locations often were void of vegetation and were dry and cracked at the time of sampling. Areas of interest were scanned in the field with the Ludlum Model 19 Micro R Meter. Where applicable, the actual soil sampling location was collected at a location of higher gamma readings. In the case of the storage ponds, the highest radiation readings were often at the lowest section of the pond where water pools and stands the longest period of time. An excavation within the “asbestos pond” allowed an interesting look at the soil profile. Dark staining on the profile was indicative of the bottom of the storage pond and had the highest field radiation readings. Field readings were at background below this stained area on the soil profile.

Distribution of U soil concentrations may be viewed in Figure 6. The data gives a limited snapshot of potential contaminant distribution movement. There is some evidence that contamination is higher upstream and contaminated sediment may have settled into the storage ponds, at least in the past. In some instances, Uranium may have been carried to the storage pond along the irrigation canals and settled in the bottom sediment of the pond. Note that the samples collected may indicate a “worst case” scenario as the soil surface was field screened prior to sampling and areas with higher readings were selected for sampling. Relatively higher levels of U were also found further north, nearer to the s mesas than at other locations. One other general area appears to have slightly elevated contamination based on soil contamination and field radiation screening. This general area is very close to the former transfer station and may be the result of settling of dust from the transfer station as these locations are not linked to other sources. In the 1950s and 1960s, mining companies used the transfer station to stockpile uranium ore that workers extracted from the mines in the nearby Lukachukai Mountains. The uranium ore was then trucked to a mill approximately 40 miles away for processing. A limited number of Radium samples were collected also and these follow a similar pattern to the U contamination and may be viewed in Figure 7.

Canals, Ponds, and Water Features

The general path of surface water was readily apparent while walking through the area of interest. Most of the storage ponds were no longer in active use, although additional storage ponds could potentially be put into use again in the future. Some landowners expressed interest in farming in the near future and some fields were kept plowed in anticipation of this future planting.

Active canals were in use to divert water from the Cove Wash to storage ponds for irrigation. It is likely that additional canals could be created or recreated in the future if farming in the area increases. Precipitation has been lower in the past couple decades than it was historically which has also reduced the amount of farming in the area. If this region received more precipitation again in the future there is likely to be more fields planted with crops.

Rainwater that falls on the mesas and mining areas south of the area of interest flows generally north in the Cove Wash through the area of interest. Some of this water may be diverted into storage ponds. Additional surface water may be trapped by some of the storage ponds directly due to their placement downhill. Due to the season and lack of precipitation, very little standing water was present at the time of sampling. Most of the Cove Wash was dry except just below Dam 1 and a few other low lying areas of the channel. Two storage ponds contained shallow, muddy water which evaporated over the course of sampling event. The relative depth of Cove Wash and the presence of larger stones and logs that have been moved within its channel indicate that a significant volume of water will move through this system at times.

Highest U concentration found in water was 516 ug/L at CWWT-15. This was from the thick and concentrated, unfiltered water in a storage pond which fully evaporated two days after sample collection. Overnight rain runoff from within Cove Wash just above Dam 1 contained U concentrations of 69.1 ug/L total and 62.8 ug/L dissolved U. The number of water samples chemistry results is extremely limited due to lack of surface water and precipitation during and prior to fieldwork.

Crops and Edible Vegetation

During the sampling event a wheat crop was found in one planted field and alfalfa in another field. Some of the local people indicated corn and squash were historically planted on their fields and a couple residents had small plots of recently planted squash seedlings. One family had a field that was planted with hay (for horses) and a second lower field that was plowed and expected to be planted with corn the following year. Pinyon or pine nuts, the edible seeds of the Pinyon pine (*Pinus edulis*) are commonly collected from the wild and eaten by the local people. The Pinyon pines grow most abundantly at higher elevations around the mines and mesas. One resident kindly provided ERT and SERAS with some of these nuts to analyze for metals. These pine nuts were collected near the mine source on the Mesas. Wild onions and other vegetation may also be gathered locally from the wild for food. Those people that farm generally save their own seed for planting, obtained seed from neighbors or purchasing from a local Trading Post if they were interested in obtaining new or different seed. A single turnip plant grew from one of the collected bulk soil samples (LabS-09) collected within a holding pond. Some wheat seeds were collected from one of the active fields during the investigation. Although some of these wheat seeds sprouted quite well in the laboratory there was not a sufficient number of seed or uniformity in germination for them to be used for the laboratory growth experiment. Overall there was only a minimal amount of active farming at the time of field sampling. A few residents had small cultivated garden plots of melons or other crops near their homes but these crops were two young to sample at the time of the investigation. However, there was evidence and indication of much more farming in the past and a good possibility that more farmland could be again cultivated in the future. Wild horses were often observed grazing in open fields and cattle move in and out of the area with the seasons. Smaller domestic farm animals (goats, chickens) were kept at some of the farms.

Laboratory Study

The twelve soils collected for laboratory studies represented soils throughout the area of interest including some of the farm fields. The goal was to obtain a representative group of soils from the area of interest. A control soil was collected near the perimeter of the Cove Chapter House, and a “worst case” soil was provided from near the mines. The field team had difficulty locating soil with higher contamination, based on field radiation screening, from around the mines. Areas that produced higher field radiation readings were generally stone and not fine soil. Most of the fine soil near the mine entrances visited had already eroded away if present in the past. Agronomic analyses of the collected bulk soils did not yield any unusual or agronomically extreme results in any of the soils. Soils in general were high in calcium and magnesium which is common in the southwest. Most of the soils were low in Fe and a couple of the collected bulk soils were low in Zn. Agricultural crops may respond positively to fertilizers containing either of these two elements. One soil (LabS05) was low in nitrogen and organic matter but this was from the field cultivated with alfalfa, a crop that may assist in fixing nitrogen to the soil and providing organic matter. The pH of most of these soils is between 7.3 and 7.9, typical for the region. The lowest pH is 6.61 from LabS01. Note that the agricultural results are based on a single composite soil sample from each location. Data concerning soil and associated plant metals uptake and contents were used toward the risk assessment. The highest concentration of U, in LabS-12, averaged 102.7 milligrams per kilogram of soil (mg/kg). The highest U concentrations from the area of interest used in the study were from LabS-09 and LabS-10 (12.5 and 12.4 mg/kg respectively), the next highest concentration was from LABS-01 at 3.45 mg/kg. The lowest Uranium concentration, from the background reference area was found to be 0.597 mg/kg.

Wheat germinated and grew well in all collected soils. The onions were a bit difficult to initially germinate in the laboratory due to the seedlings physically pushing themselves above the soil line and desiccating. Therefore these onions were replanted a second time slightly deeper below the soil surface. The onions then also grew equally well on all collected bulk soils. A few of the onion pots suffered from a common seedling fungus early in the experiment, but 2-3 successful onion pots per location were still harvested at the end of the study. Photographs of the growth experiment may be found in the photograph section of this report.

Focused Risk Assessment.

The Focused Risk Assessment may be found in Appendix E. Data from the laboratory experiment and field sampling were used in creating the risk assessment. The ecosystem potentially at risk is the terrestrial community present within the Cove Wash watershed. Plants inhabit the soil and directly absorb contaminants through dermal contact with soil particles and uptake of soil solution by the roots. Terrestrial receptors which consume plants growing in fields irrigated by surface water are also of concern. Birds and mammals that utilize the fields as a foraging area may be exposed to contaminants through dermal contact with soil and water, through ingestion of contaminated food items or incidental ingestion of soil or sediment, and through direct contact with surface water. No conclusions regarding public health significance or human health risk associated with the consumption of water, crops, or livestock from this area can be made based on this screen.

Three lines of evidence were used to assess site-specific risk to ecological receptors from As, Ba, Pb, Mo, Se, Th, U, Ra-226 and Ra-228 present in soils at the Cove Wash Site. These are the screening of measured concentrations in abiotic media against ecological benchmarks, the laboratory plant study, and dietary exposure models.

The maximum concentration of all of the above COPCs except Mo exceeded conservative ecological screening values in at least one abiotic medium. The maximum measured concentration of As, Pb and Mo in soil was below the ecological screening value. For soils, with the exception of RA-226, calculated Hazard Quotients (HQs) are less than 5.

In the laboratory wheat and onion germinated and grew well on all of the collected soils. Uptake of U by wheat was low; detected concentrations ranged from 0.227 to 0.824 mg/kg dw. U was only detected in 4 of 36 wheat samples. U was detected in 15 of the 31 onion samples, at concentrations ranging from 0.072 to 3.89 mg/kg dry weight.

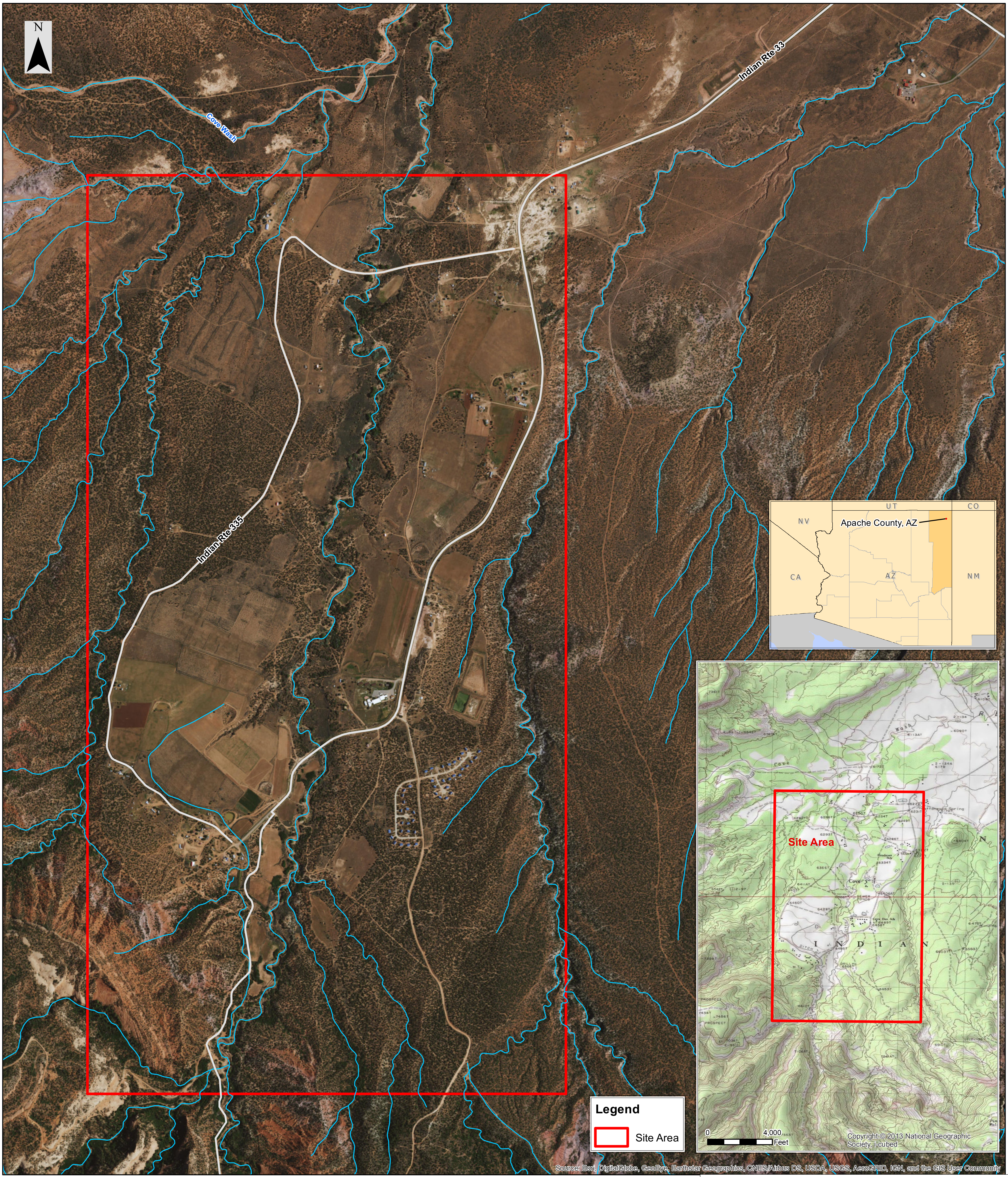
HQs for herbivorous and carnivorous birds exceed 1.0 for exposure to Pb and to U when the toxic endpoint is kidney lesions; it cannot be concluded there is no risk to herbivorous and carnivorous birds from dietary exposure to these COPCs.

Using maximum exposure concentrations and conservative exposure parameters, herbivorous mammals are at risk from exposure to U concentrations in soils and field-collected or laboratory plants, when the toxic endpoint is kidney lesions.

Using average exposure concentrations and exposure parameters, there is only model-calculated risk to non-ruminant herbivorous mammals from exposure to U concentrations in soils and laboratory plants, when the toxic endpoint is kidney lesions.

Based on the study results, it is concluded that maximum measured COPC concentrations (with the exception of Mo) in surface water and in soil do exceed conservative ecological screening benchmarks.

The dietary exposure models indicate model-calculated risk to herbivorous mammals from dietary exposure to U based on conservative or representative exposure estimates when the toxic endpoint is kidney lesions.



Base map created using ESRI World Imagery.

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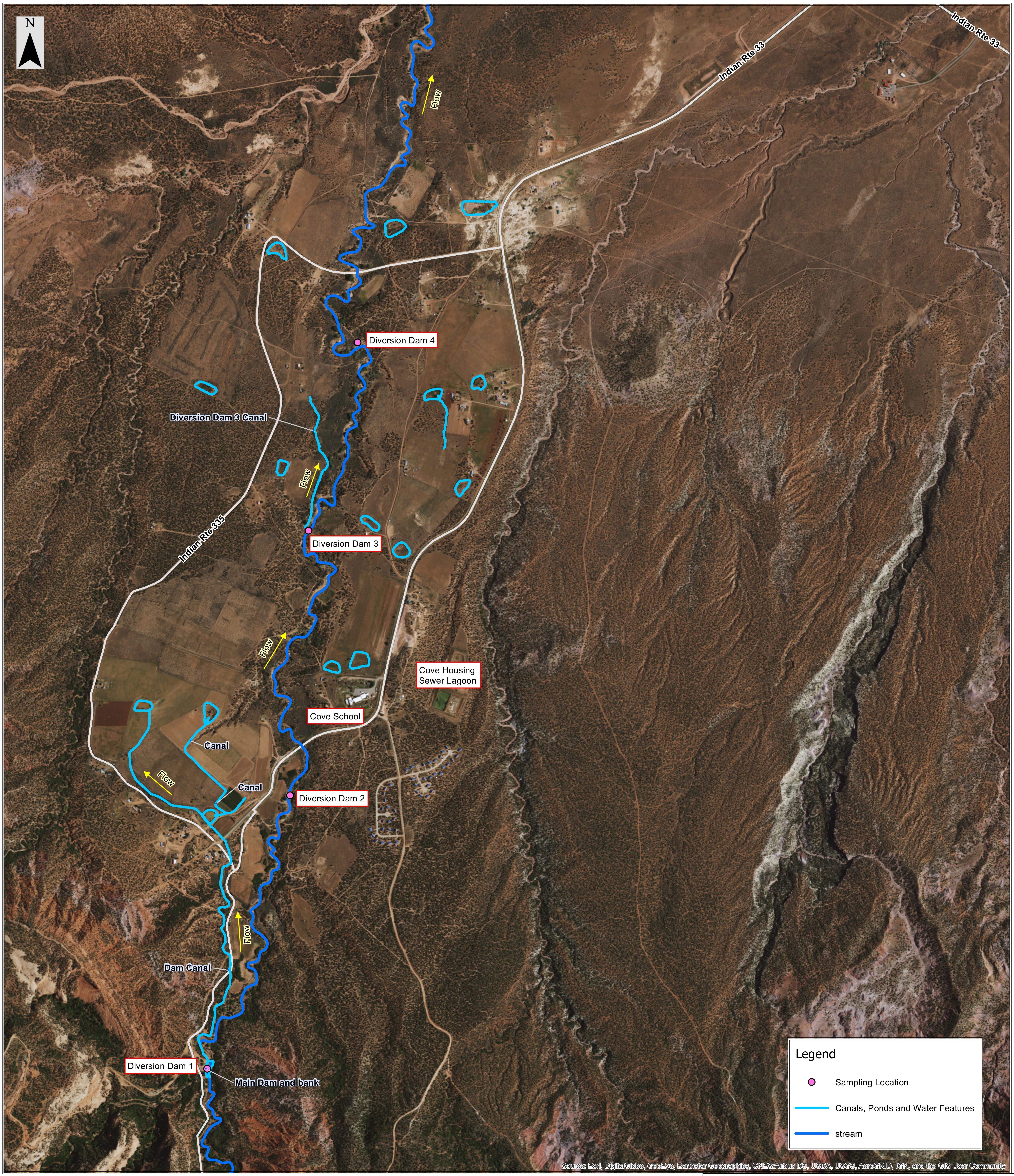
U.S. EPA Environmental Response Team
Scientific Engineering Response and Analytical Services
EP-W-09-031
W.A.# SERAS-297

Figure 1
Site Location Map
R9 Cove Irrigation Crops Study
Cove Arizona



Base map created using ESRI World Imagery, sample location GPS data in 2016.

Map Creation Date: 23 February 2017

Coordinate system: Arizona State Plane East
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Figure 2
Canals, Ponds, and Water Features
R9 Cove Irrigation Crops Study
Cove Arizona

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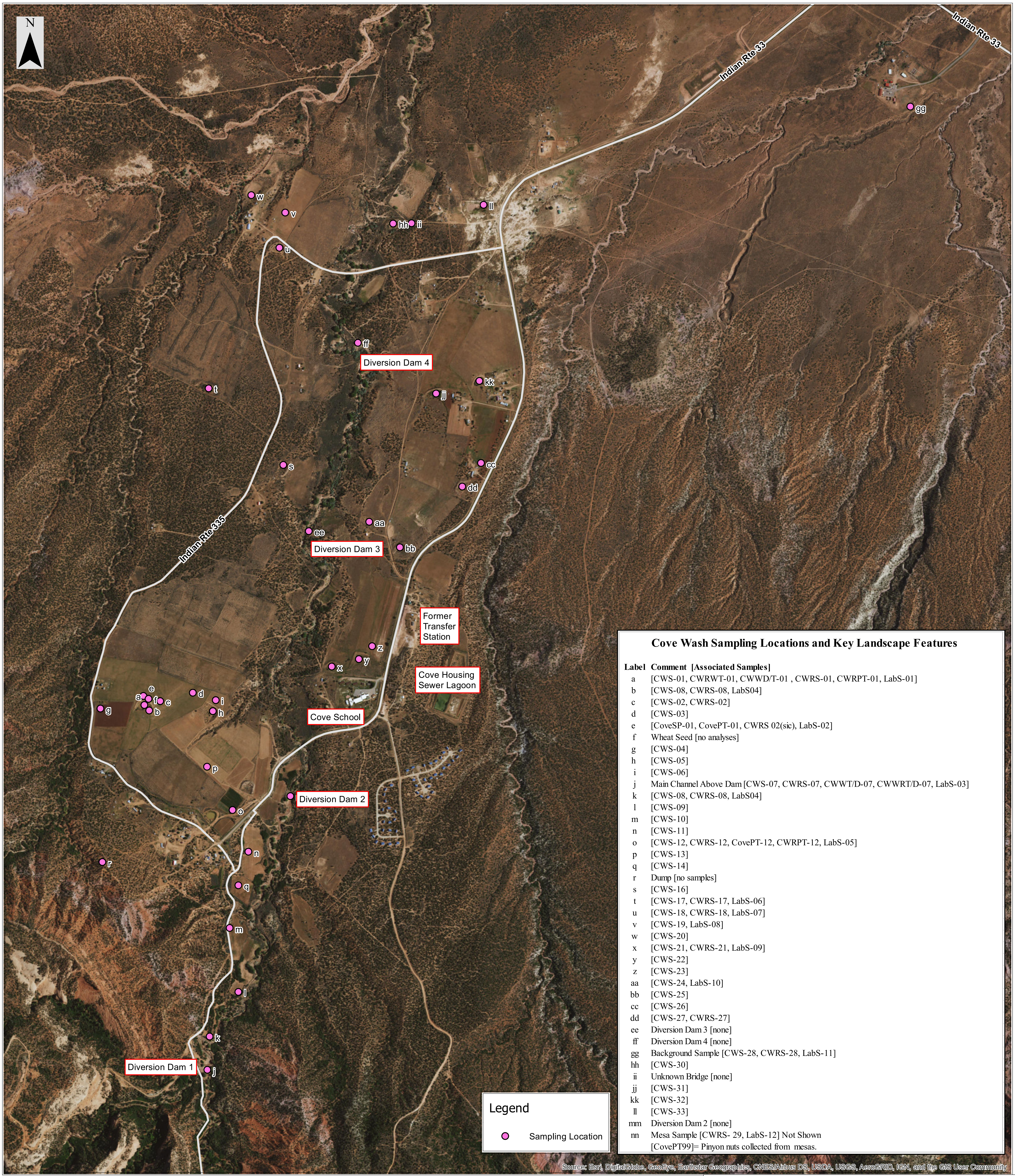

Cove Wash Sampling Locations and Key Landscape Features

Label	Comment [Associated Samples]
a	[CWS-01, CWRWT-01, CWWD/T-01 , CWRS-01, CWRPT-01, LabS-01]
b	[CWS-08, CWRS-08, LabS04]
c	[CWS-02, CWRS-02]
d	[CWS-03]
e	[CoveSP-01, CovePT-01, CWRS 02(sic), LabS-02]
f	Wheat Seed [no analyses]
g	[CWS-04]
h	[CWS-05]
i	[CWS-06]
j	Main Channel Above Dam [CWS-07, CWRS-07, CWWT/D-07, CWWRT/D-07, LabS-03]
k	[CWS-08, CWRS-08, LabS04]
l	[CWS-09]
m	[CWS-10]
n	[CWS-11]
o	[CWS-12, CWRS-12, CovePT-12, CWRPT-12, LabS-05]
p	[CWS-13]
q	[CWS-14]
r	Dump [no samples]
s	[CWS-16]
t	[CWS-17, CWRS-17, LabS-06]
u	[CWS-18, CWRS-18, LabS-07]
v	[CWS-19, LabS-08]
w	[CWS-20]
x	[CWS-21, CWRS-21, LabS-09]
y	[CWS-22]
z	[CWS-23]
aa	[CWS-24, LabS-10]
bb	[CWS-25]
cc	[CWS-26]
dd	[CWS-27, CWRS-27]
ee	Diversion Dam 3 [none]
ff	Diversion Dam 4 [none]
gg	Background Sample [CWS-28, CWRS-28, LabS-11]
hh	[CWS-30]
ii	Unknown Bridge [none]
jj	[CWS-31]
kk	[CWS-32]
ll	[CWS-33]
mm	Diversion Dam 2 [none]
nn	Mesa Sample [CWRS- 29, LabS-12] Not Shown
	[CovePT99]= Pinyon nuts collected from mesas.

Base map created using ESRI World Imagery, sample location GPS data and sampling data in 2016.

Map Creation Date: 23 February 2017

Coordinate system: Arizona State Plane East
FIPS: 0201
Datum: NAD83
Units: Feet

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EP-W-09-031
W.A.# SERAS-297

Figure 3
Cove Wash Sampling Locations
and Key Landscape Features [Associated Samples]
R9 Cove Irrigation Crops Study
Cove Arizona

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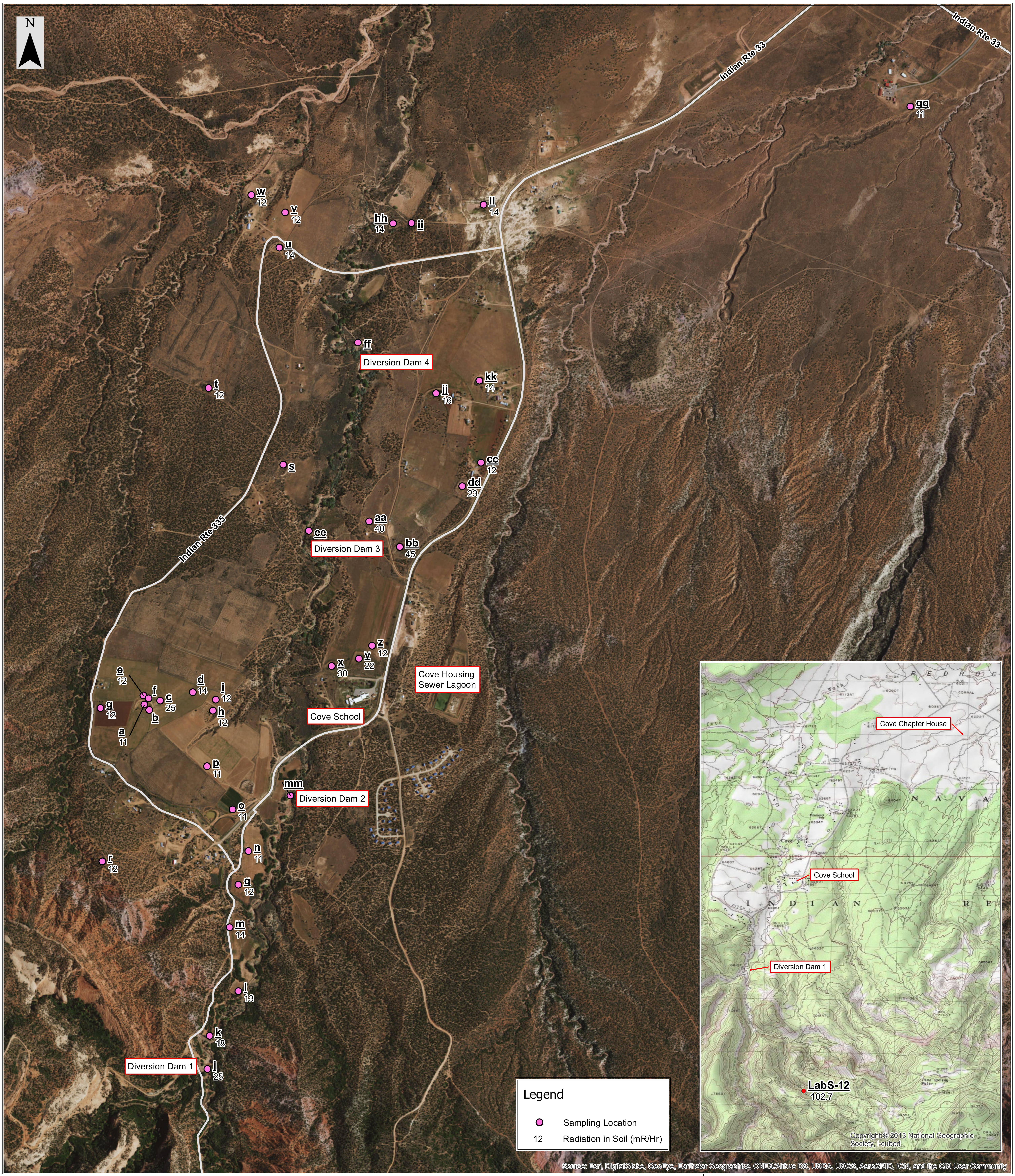

Base map created using ESRI World Imagery, sample location GPS data and sampling data in 2016.

Map Creation Date: 23 February 2017

Coordinate system: Arizona State Plane East
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Datum: NAD83
Units: Feet

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W.A.# SERAS-297

Figure 4
Field Radiation Measurements (MicroRems/Hour)
R9 Cove Irrigation Crops Study
Cove Arizona

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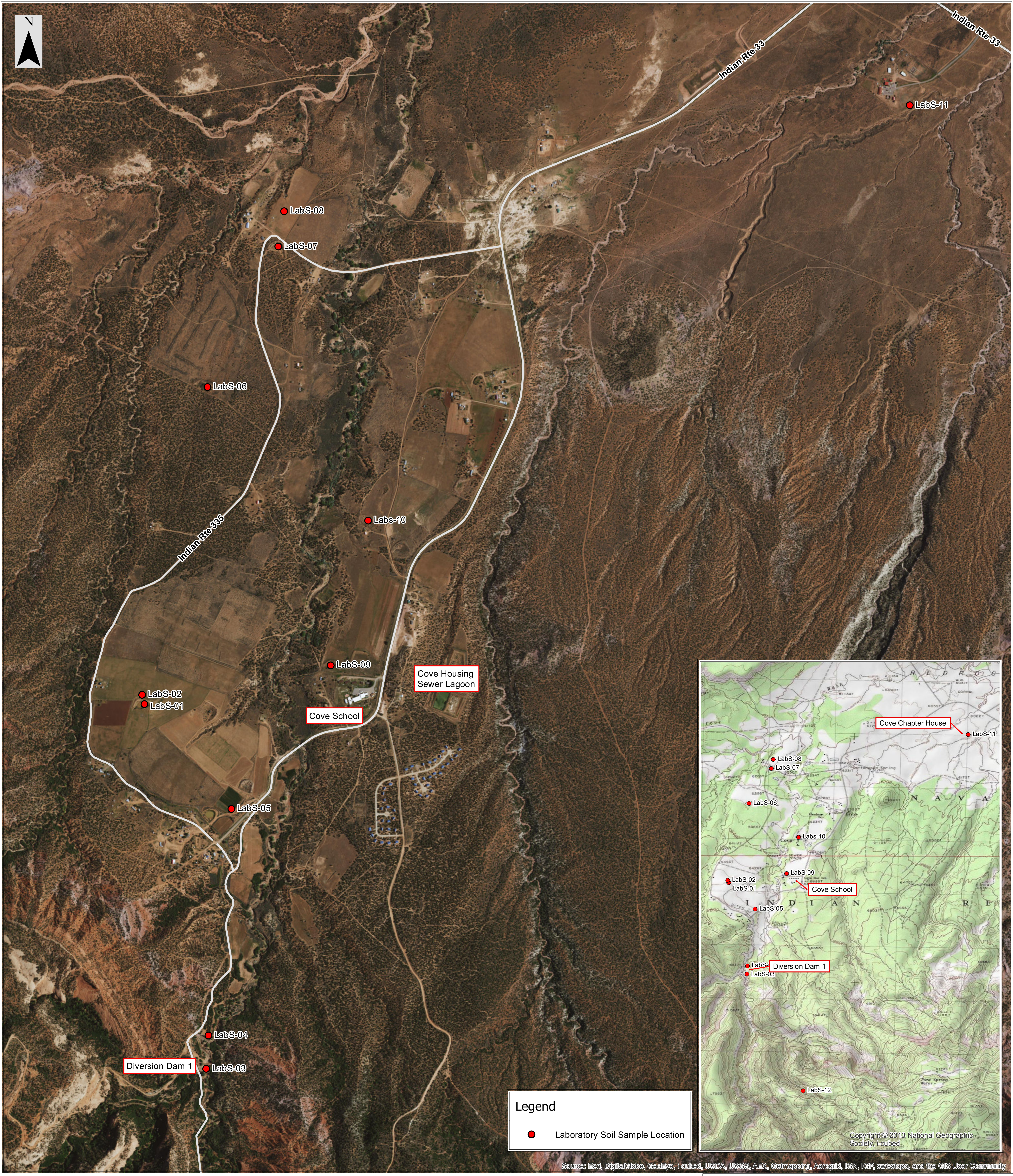

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U.S. EPA Environmental Response Team
Scientific Engineering Response and Analytical Services
EP-W-09-031
W.A.# SERAS-297

Figure 5
Cove Wash Laboratory Soils Collected
for Further Evaluation and Growth Room Testing
R9 Cove Irrigation Crops Study
Cove Arizona

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